CLAIMS

1. A single crystal diamond prepared by CVD and having at least one of the following characteristics:

   (i) in the off state, a resistivity R_1 greater than 1×10^{12} Ω cm at an applied field of 50 V/μm measured at 300 K;

   (ii) a high breakdown voltage in the off state, and high current with long carrier life time in the on state;

   (iii) an electron mobility (μ_e) measured at 300K greater than 2400 $cm^2V^{-1}s^{-1}$;

   (iv) a hole mobility (μ_h) measured at 300K greater than 2100 $cm^2V^{-1}s^{-1}$; and

   (v) a high collection distance greater than 150 μm measured at an applied field of 1 V/μm and 300 K.

2. A single crystal diamond according to claim 1 which has a resistivity greater than 2×10^{13} Ω cm at an applied field of 50 V/μm measured at 300 K.

3. A single crystal diamond according to claim 1 which has a resistivity R_1 greater than 5×10^{14} Ω cm at an applied field of 50 V/μm measured at 300 K.

4. A single crystal diamond according to any one of the preceding claims which has a $\mu\tau$ product measured at 300 K greater than $1.5 \times 10^{-6} cm^2V^{-1}$ where μ is the mobility and τ is the lifetime of the charge carriers.

5. A single crystal diamond according to claim 4 which has a $\mu\tau$ product measured at 300 K of greater than 4,0 x $10^{-6}cm^2V^{-1}$.

6. A single crystal diamond according to claim 4 which has a $\mu\tau$ product measured at 300 K greater than 6,0 x $10^{-6}cm^2V^{-1}$.

7. A single crystal diamond according to ~~any~~ one of the preceding claims which has an electron mobility (μ_e) measured at 300 K greater than 3 000 $cm^2V^{-1}s^{-1}$.

8. A single crystal diamond according to claim 7 which has an electron mobility (μ_e) measured at 300 K greater than 4 000 $cm^2V^{-1}s^{-1}$.

9. A single crystal diamond according to ~~any~~ one of the preceding claims which has a hole mobility measured at 300 K greater than 2 500 $cm^2V^{-1}s^{-1}$.

10. A single crystal diamond according to claim 9 which has a hole mobility measured at 300 K greater than 3 000 $cm^2V^{-1}s^{-1}$.

11. A single crystal diamond according to any one of the preceding claims which has a collection distance measured at 300 K greater than 400 μm.

12. A single crystal diamond according to claim 11 which has a collection distance measured at 300 K greater than 600 μm.

13. A single crystal diamond according to any one of the preceding claims which has each of the characteristics (i), (ii), (iii), (iv) and (v).

14. A method of producing a single crystal diamond according to any one of the preceding claims which includes the steps of providing a diamond substrate having a surface which is substantially free of crystal defects, providing a source gas, dissociating the source gas and allowing homoepitaxial diamond growth on the surface which is substantially free of crystal defects in an atmosphere which contains less than 300 parts per billion nitrogen.

15. A method according to claim 14 wherein the substrate is a low birefringence type Ia or IIb natural, Ib or IIa high pressure/high temperature synthetic diamond.

16. A method according to claim 14 wherein the substrate is a CVD synthesised single crystal diamond.

17. A method according to any one of claims 14 to 16 wherein the surface on which diamond growth occurs has a density of surface etch features related to defects below $5 \times 10^3/mm^2$.

18. A method according to any one of claims 14 to 16 wherein the surface on which diamond growth occurs has a density of surface etch features related to defects below $10^2/mm^2$.

19. A method according to any one of claims 14 to 18 wherein the surface on which the diamond growth occurs is subjected to a plasma etch to minimise surface damage of the surface prior to diamond growth.

20. A method according to claim 19 wherein the plasma etch is an *in situ* etch.

21. A method according to claim 19 or claim 20 wherein the plasma etch is an oxygen etch using an etching gas containing hydrogen and oxygen.

22. A method according to claim 21 wherein the oxygen etch conditions are a pressure of 50 to 450 x 10^2 Pa, an etching gas containing an oxygen content of 1 to 4%, an argon content of up to 30% and the balance hydrogen, all percentages being by volume, a substrate temperature of 600 to 1100°C, and an etch duration of 3 to 60 minutes.

23. A method according to claim 19 or claim 20 wherein the plasma etch is a hydrogen etch.

24. A method according to claim 23 wherein the hydrogen etch conditions are a pressure of 50 to 450 x 10^2 Pa, an etching gas containing hydrogen and up to 30% by volume argon, a substrate temperature of 600 to 1100°C and an etch duration of 3 to 60 minutes.

25. A method according to ~~any one of claims~~ 19 to 24 wherein the surface on which the diamond growth occurs is subjected to both an oxygen and a hydrogen etch to minimise surface damage of the surface prior to diamond growth.

26. A method according to claim 25 wherein the oxygen etch is followed by a hydrogen etch.

27. A method according to any one of claims 19 to 26 wherein the surface R_A of the surface on which the diamond growth occurs is less than 10 nanometers prior to that surface being subjected to the plasma etching.

28. A method according to any one of claims 14 to 27 wherein the diamond growth takes place in an atmosphere which contains less than 100 ppb nitrogen.

29. A method according to ~~any one~~ of claims 14 to 28 wherein the surface on which diamond growth occurs is substantially a {100}, {110}, {113} or {111} surface.

30. A method according to ~~any one of~~ claims 14 to 29 wherein the dissociation of the source gas occurs using microwave energy.

31. The use of a single crystal diamond according to any one of claims 1 to 13 in an electronic application.

32. The use of a single crystal diamond according to any one of claims ~~1 to 13~~ as a detector element or switching element.

33. The use of a single crystal diamond of any one of claims ~~1 to 13~~ as a component in an opto-electric switch.

34. A detector element or switching element comprising a single crystal diamond according to ~~any~~ one of claims 1 to 13.